TEST REPORT

INSTALLATION AND ENVIRONMENTAL TEST OF LIGHT SIGNAL MONITOR FACILITY AN/TSQ-( )

DSL R-146

Prepared under Navy
Office of Naval Research
Contract N00014-66-C0118

DEFENSE SYSTEMS LABORATORY
SYRACUSE UNIVERSITY RESEARCH CORPORATION

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1 June 1966

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ABSTRACT

In accordance with Commandant of the Marine Corps (CSY-3-rep) letter to Commanding General, Marine Corps Supply Center (MCSC), Albany, Georgia, Subject: Project Order 5-0038 Special Signal Reconnaissance System; testing of, dated 25 March 1966, one prototype Light Signal Monitor Facility AN/TSQ-( ) was subjected to specified shock, vibration, and environmental testing at Albany, Georgia. The system met or exceeded the requirements of all tests to which it was subjected. Although minor damage was sustained by the shelter as a result of the drop test, the electronic equipment continued to operate properly. A transistor failure experienced in the AN/PRC-47 Radio Set when it was switched to high power was determined by MCSC personnel to be unrelated to the system testing. Comments on the testing and recommendations for procurement systems have been included at the end of this report.

TEST REPORT

INSTALLATION AND ENVIRONMENTAL TEST OF LIGHT SIGNAL MONITOR FACILITY AN/TSQ-( )

Background

The prototype Light Signal Monitor Facility AN/TSQ-( ) was developed under Office of Naval Research Contract NOnr 2556(00). The system consists of the following component equipment in the quantities indicated installed in an S-155 equipment shelter (Figures 1 and 2):

Qty.	Equipment
3	AN/URR-52A Panoramic Data Receiving Set (Communication Electronics, Inc., Model RS-111-1B-7).
3	R-1122 Receiver ((Collins Radio Co., Model 51S-1F (modified))
3	Selective Voltmeter, Rycom Model 2174A-610A (modified)
1	Signal Monitor, Communication Electronics, Inc., Model SM-8511 (modified)
1	System Selector Panel (designed and fabricated at SURC)
1	28 v DC Power Supply (designed and fabricated at SURC)
1	Intercom (designed and fabricated at SURC)
1	Oscilloscope, Hewlett-Packard Model 140A with Model 1402A Dual Trace Amplifier and Model 1420A Time Base.

Qty.	Equipment
3	Audio Recorder, Ampex Model PR-10-2 (modified)
1	Microphone Panel (designed and fabricated at SURC)
3	AN/TGC-14A(V) Teletypewriter Set
2	AFSAV 39C Rekeyer (modified)
1	AN/PRC-47 Radio Set

All of the listed equipment, with the exception of the AN/PRC-47 Radio Set, is mounted in 19-inch equipment racks especially designed for the AN/TSQ-( ). The curb-side rack is an integral three-bay structure shock-mounted to the shelf formed by the shelter indentation and to the shelter curb-side bulkhead (Figure 1). The road-side rack is an integral two-bay structure shock-mounted in the same manner (Figure 2).

Side brackets have been installed on individual items of equipment as shown in Figure 3. Mating brackets have been installed at appropriate locations in the rack structures as shown in Figures 4 and 5. This bracket arrangement provides a shelf-type mounting for each piece of equipment, distributing shock and vibration effects along the length of each bracket while still permitting free air flow through the rack for equipment cooling. All electrical connections to each piece of equipment are made through quick-disconnect connectors, facilitating rapid installation and removal of the equipment.

Rubber gasketing has been installed around each of the two integral racks making them semi-airtight. Cool air from outside the shelter

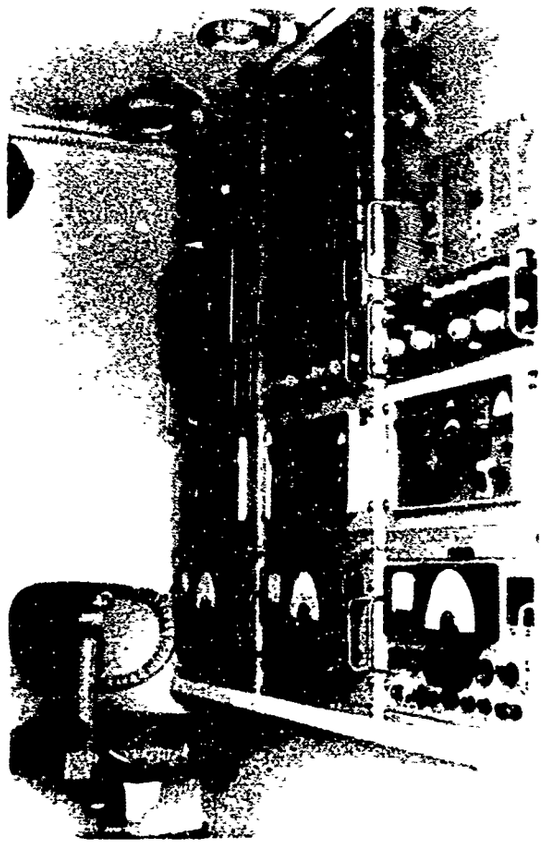

FIGURE 1. INTERNAL VIEW OF SYSTEM - CURB SIDE

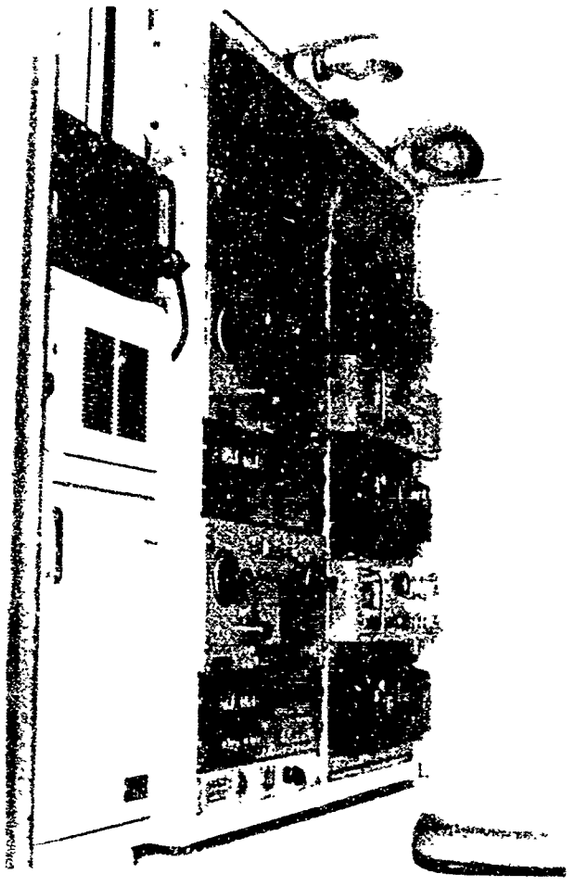

FIGURE 2. INTERNAL VIEW OF SYSTEM - ROAD SIDE

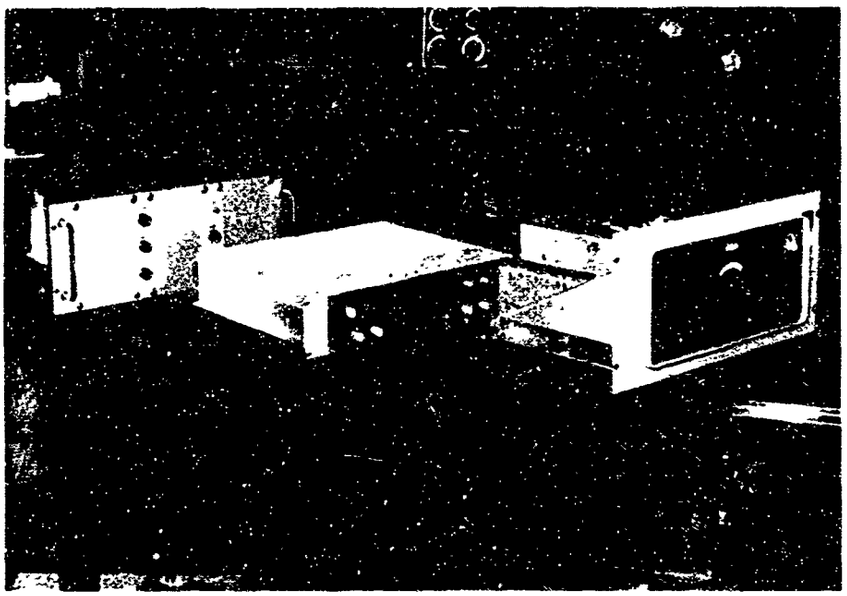

FIGURE 3. MOUNTING BRACKETS INSTALLEDON ELECTRONIC EQUIPMENT

FIGURE 4. MOUNTING BRACKETS INSTALLED IN RACKS

FIGURE 5. MOUNTING BRACKETS INSTALLED IN RACKS

is drawn into each rack through intake ports located in the lower forward end of the shelter. Exhaust fans and ducting are used to draw this air through the racks to be exhausted to the outside of the shelter through exhaust ports in the upper rear end of each rack. In this way, nearly all of the equipment heat is eliminated from the shelter interior by fans, greatly reducing the system air conditioning requirements. A vent arrangement has been installed in one of the air ducts to provide optional exhaust of the equipment heat to the operator compartment, augmenting the shelter heating system.

Test Requirements

As directed by Commandant of the Marine Corps (CSY-3-rep) letter to Commanding General, Marine Corps Supply Center (MCSC), Albany, Georgia, Subject: Project Order 5-0038 Special Signal Reconnaissance System; testing of, dated 25 March 1966, one Light Signal Monitor Facility AN/TSQ-( ) was subjected to the following tests at the Marine Corps Supply Center, Albany, Georgia:

1. Rail Transport - The shelter, mounted on an M37 truck with all components mounted for transit, shall be placed on a railway flat car and impacted into a stationary mass of five times its weight at speeds of five (5) miles per hour for one impact and nine (9) miles an hour for four (4) impacts. The system shall be fully operable after each impact.

2. Truck Transport - The shelter shall be mounted on an M37 truck with all components mounted for transit and transported over paved and unpaved roads at speeds up to fifty (50) miles per hour on paved roads, and twenty (20) miles per hour on unpaved roads for a total distance of five hundred (500) miles. During the course of the test there shall be at least ten (10) abrupt stops from speeds of fifteen (15) miles per hour. The equipment shall further be transported ten (10) miles cross country. The system shall be fully operable at the completion of the test. Operational checks shall be performed after each fifty (50) mile segment of the test.

3. Enclosure Test - The system with all components installed for transit shall be subjected to the enclosure test as specified in paragraph 5.2.26 of MIL-STD-108 for water tight enclosures.

4. Heat Test - The system with all components installed shall be operated continuously with all components on for a period of eight (8) hours. The air conditioner shall remain off and the blower fans on during the test. At the end of the test there should be no damage to the system or its components.

5. Drop Test - The system with all components installed for transit shall be suspended by four corners at a height of one (1) foot and dropped once on a hard earth surface. There should be no damage to the system or its components.

6. Tilt Test - The system with all components installed for transit shall be lifted by each pair of corners until it hangs suspended from the surface by the lifting device, then lowered without dropping. There shall be no damage to the system or the components.

Test Procedure

Personnel and facilities for the testing were provided by the Marine Corps Supply Center who also performed the tests The following paragraphs describe in some detail each test performed. The tests are discussed in the order in which they were performed.

1. Truck Transport - The shelter, mounted on an M37 truck with all components mounted for transit, was transported over paved and unpaved roads for a total distance of five hundred miles. During the course of the test there were at least ten abrupt stops from a speed of fifteen miles per hour. The equipment was further transported ten miles cross-country. The following table compares the specified maximum speeds with the maximum speeds actually attained in each test:

Test	Specified Maximum Speed (mph)	Actual Maximum Speed (mph)
Paved Roads	50	50
Unpaved Roads	20	30
Cross-Country	-	15

During the truck transport test, the shelter was secured to the truck with four turnbuckle cables, one cable connected between each upper corner of the shelter and the corresponding corner of the truck bed.

Figures 6 and 7 show two typical portions of the route covered during the road test. Figures 8, 9, and 10 show typical portions of the route covered during the cross-country test.

Operational checks of the system were performed after each fifty-mile segment of the road test and at the completion of the cross-country test. The system remained fully operable throughout the test.

2. Rail Transport - The shelter, mounted on an M37 truck with all components mounted for transit, was placed on a railway flat car and impacted into a stationary mass of five times its weight. The stationary mass was represented by a string of five coupled flat cars, each identical to the car on which the system was installed.

   For the rail transport test, the shelter was secured to the vehicle with diagonal tie-down cables in addition to the corner cables used for the truck transport test.

FIGURE 6. TRUCK TRANSPORT TEST (ROAD TEST)

FIGURE 7. TRUCK TRANSPORT TEST (ROAD TEST)

FIGURE 8. TRUCK TRANSPORT TEST (CROSS-COUNTRY)

FIGURE 9. TRUCK TRANSPORT TEST (CROSS-COUNTRY)

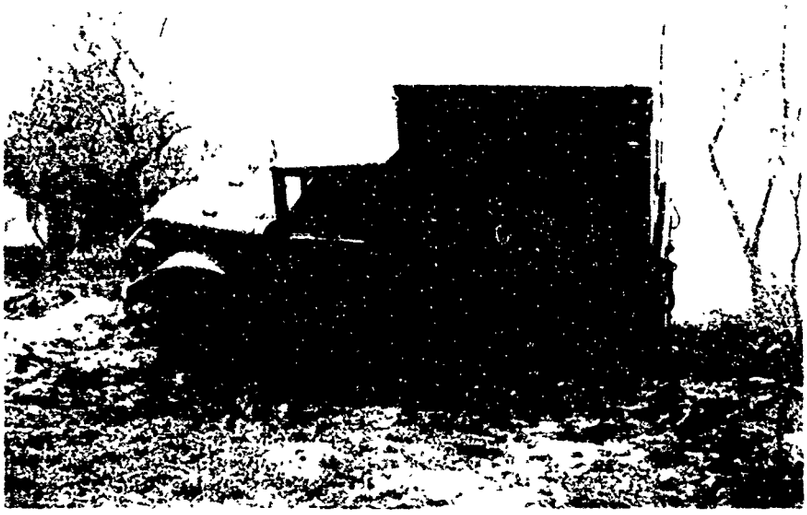

FIGURE 10. TRUCK TRANSPORT TEST (CROSS-COUNTRY)

Since railroad personnel had installed an impact meter on the car with the shelter (Figure 11), it was hoped that a quantitative impact record could be included in this report. However, during the early part of the impact testing, the meter indicating mechanism was driven against the stops and the meter ceased to operate.

The first three impacts were performed with the system being driven backward into the stationary mass (Figure 12). The system was then reversed for the last two impacts (Figure 13). The following table indicates the results of the impact testing:

Impact No.	Specified Impact Speed (mph)	Actual Impact Speed (mph)	Check	Results
1	5	7	Operational	All equipment fully operable
2	9	9	Operational	Rear curb side shelter tie-down cable pulled loose (Figure 14). All equipment fully operable.
3	9	9	Visual	No visual damage
4	9	11	Visual	Rear road side shelter tie-down cable snapped (Figure 15).

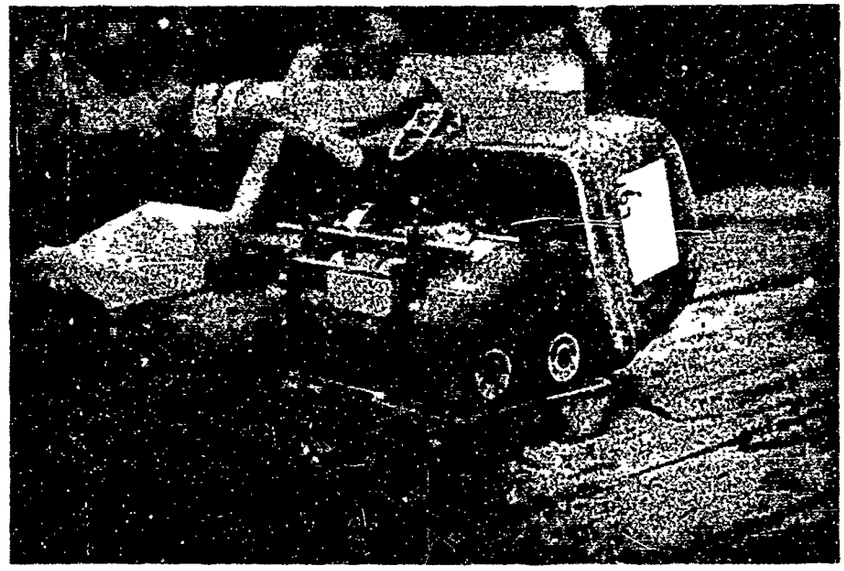

FIGURE 11. IMPACT METER MOUNTED ON FLAT CAR

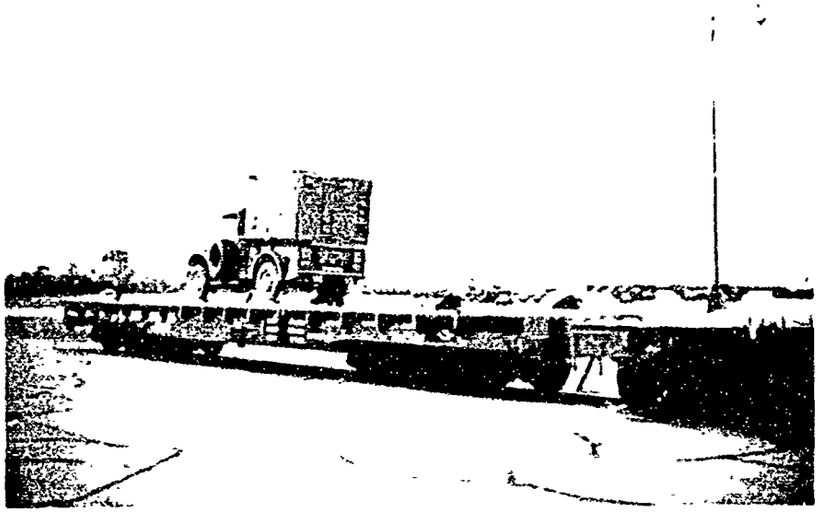

FIGURE 12. RAIL TRANSPORT TEST

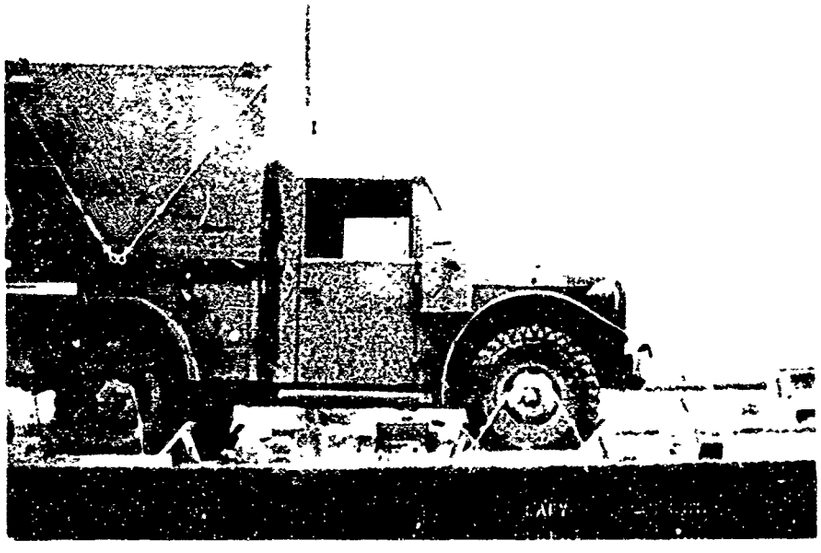

FIGURE 13. RAIL TRANSPORT TEST

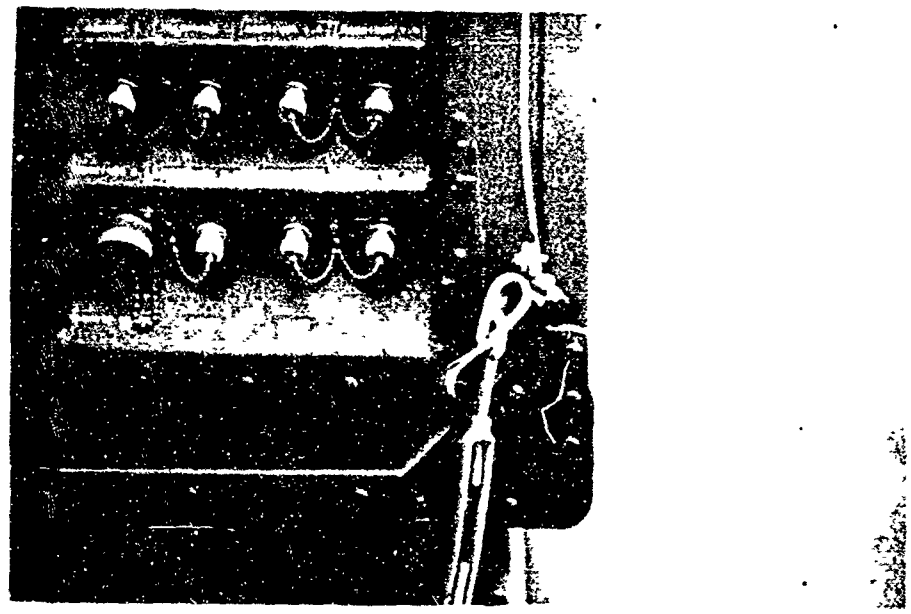

FIGURE 14. IMPACT NO. 2 DAMAGE

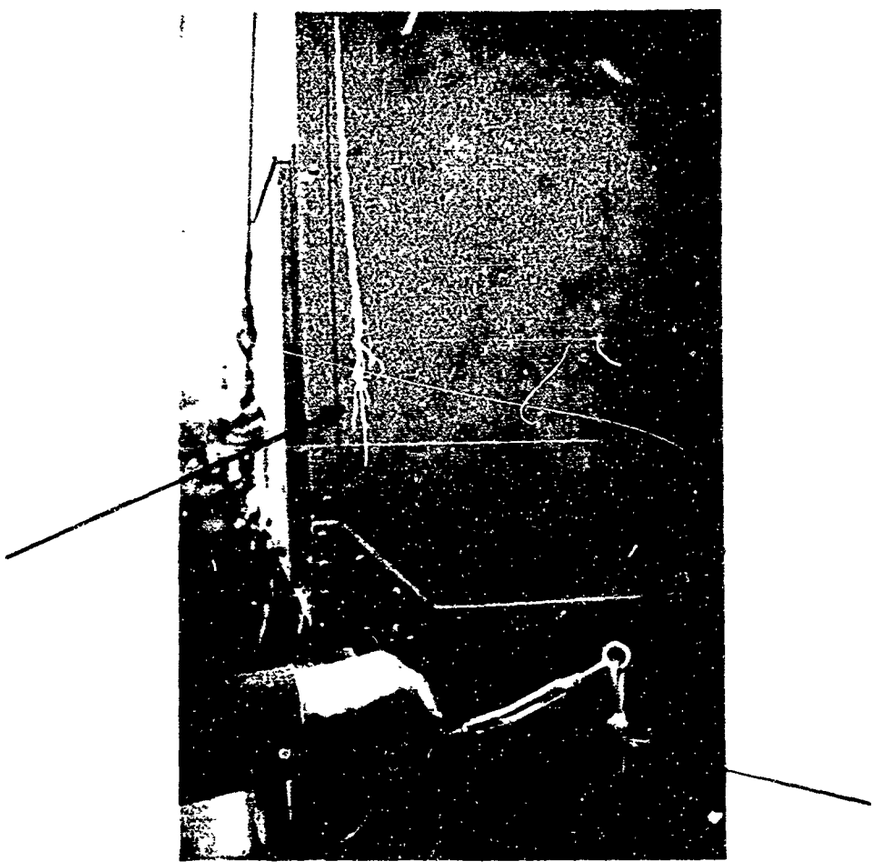

FIGURE 15. IMPACT NO. 4 DAMAGE

Impact No.	Specified Impact Speed (mph)	Actual Impact Speed (mph)	Check	Results
5	9	12	Operational	Front curb side vehicle tie-down cable snapped (Figure 16). All equipment fully operable.

3. Enclosure Test - A stream of water at 30 psi was directed from a 45 degree angle into each opening and seam of the shelter. The system satisfied all requirements of paragraph 5.2.26 of MIL-STD-108 for water tight enclosures. Figures 17 and 18 show the system undergoing the enclosure test.

4. Tilt Test - The system, with all components installed for transit, was lifted by each pair of corners and tilted through its equilibrium point The relatively high center of gravity of the system due to the shape of the shelter caused the critical tilt angle to be reached before the system became fully suspended from the surface. When the critical tilt angle was then exceeded, the shelter started to tip over, being stopped only by the suspending cables snapping taut. In this way, the system was not only tilted further than it would be when fully suspended but it was also subjected to a whipping action as it tried to tip over.

   Figures 19 through 22 show the system being lifted by each pair of corners. There was no damage to the system or its components as a result of the tilt test.

FIGURE 16. IMPACT NO. 5 DAMAGE

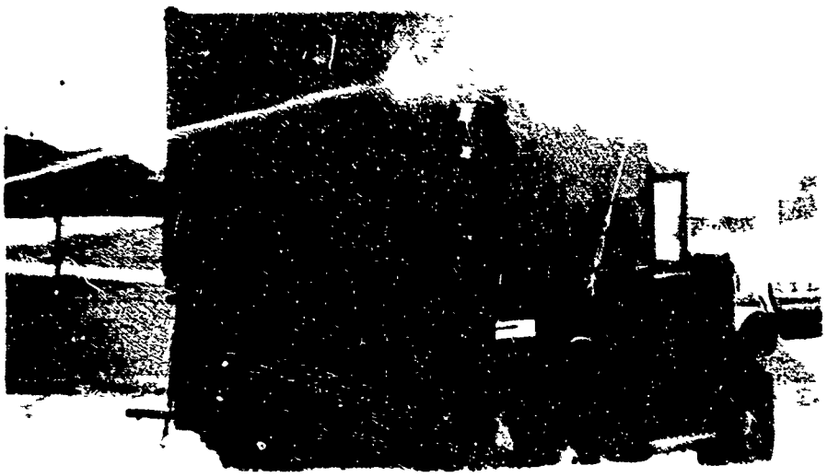

FIGURE 17. ENCLOSURE TEST

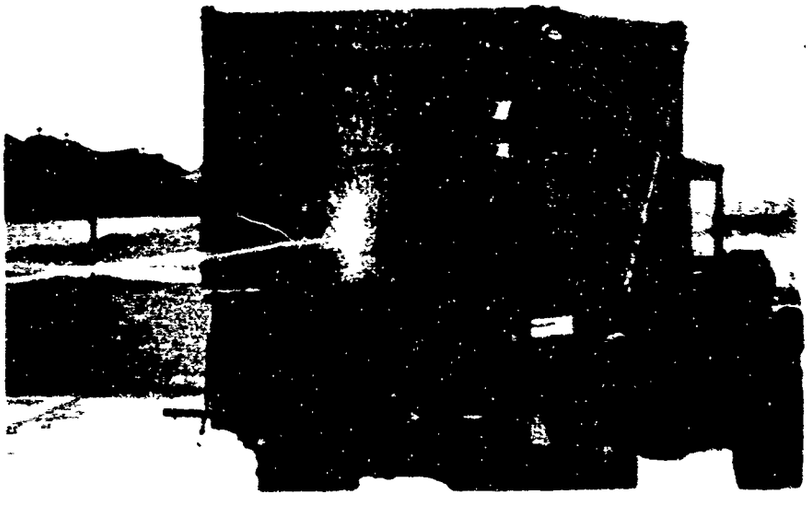

FIGURE 18. ENCLOSURE TEST

FIGURE 19. TILT TEST

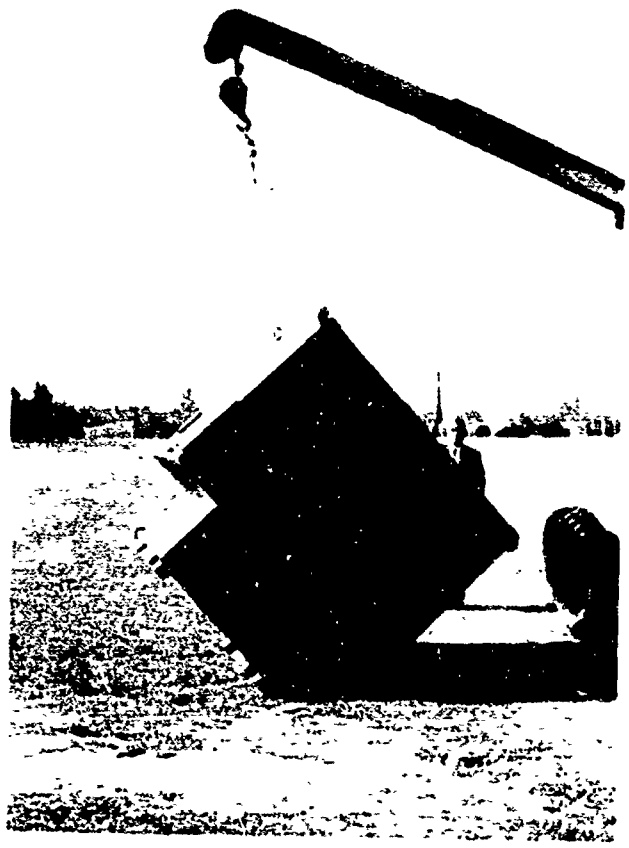

FIGURE 20. TILT TEST

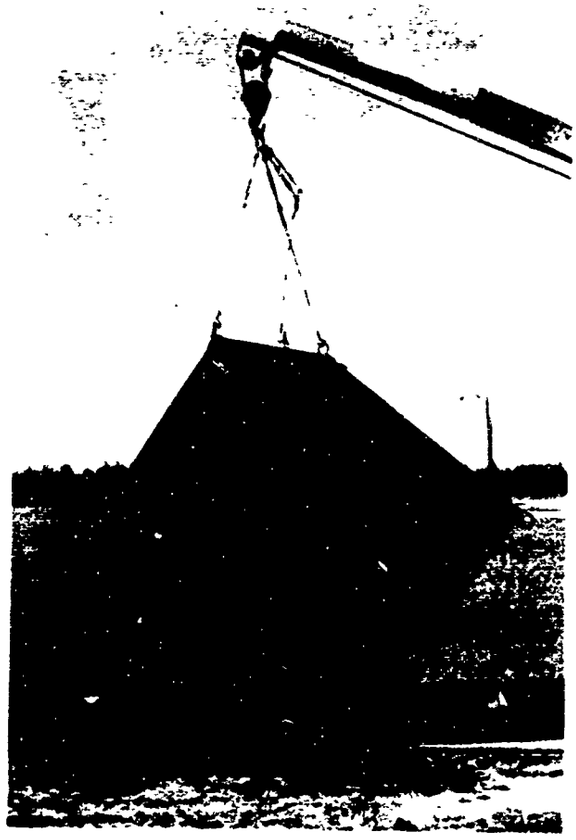

FIGURE 21. TILT TEST

FIGURE 22. TILT TEST

5. Drop Test - The system, with all components installed for transit was suspended by four corners at a height of 1 1/2 feet (rather than the specified one foot height) and dropped once on a hard earth surface. The shelter sling was connected to the crane's hook with a rope-actuated snap link. When the control rope was pulled, the shelter sling became completely disengaged from the crane cable, allowing the system to free-fall to the ground.

Figure 23 shows the suspended system just prior to being dropped. Since the system was not perfectly balanced, it tended to tilt forward slightly as it fell. Figures 24 and 25 show the resultant minor crumpling of the shelter and skids. Figure 26 and 27 show the shelter damage beneath each equipment rack shock mount.

A system operational test performed immediately following the drop test indicated no damage to the component equipment. Within the following two hours, while readying the system for the heat test, the following two minor malfunctions occurred:

a. One teletype printer operated erratically. The problem was found to be a loose binding post connection on the printer signal patch box. Once this connection was tightened, the printer operated properly.

b. The AN/PRC-47 transceiver failed to operate when switched to high power. The problem was found to be the failure of a power transistor. The troubleshooting and repair was done by personnel of the SSB calibration and repair shop in the MCSC

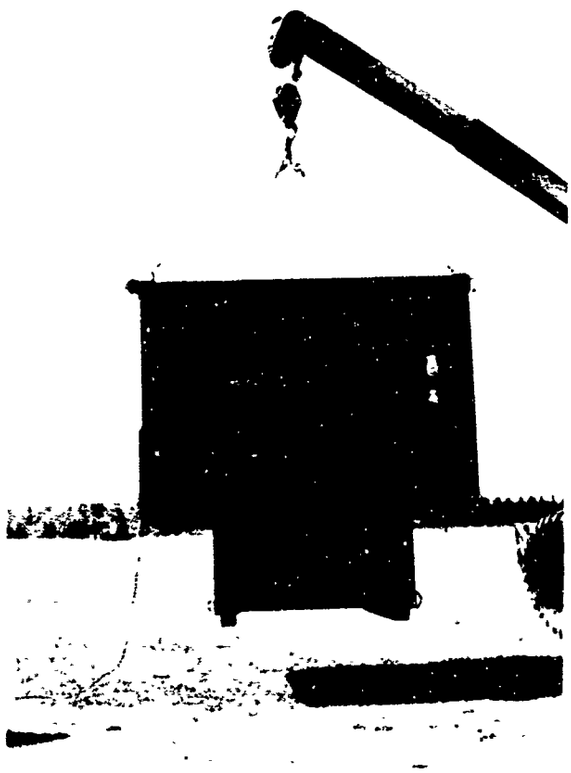

FIGURE 23. DROP TEST - PRIOR TO DROP

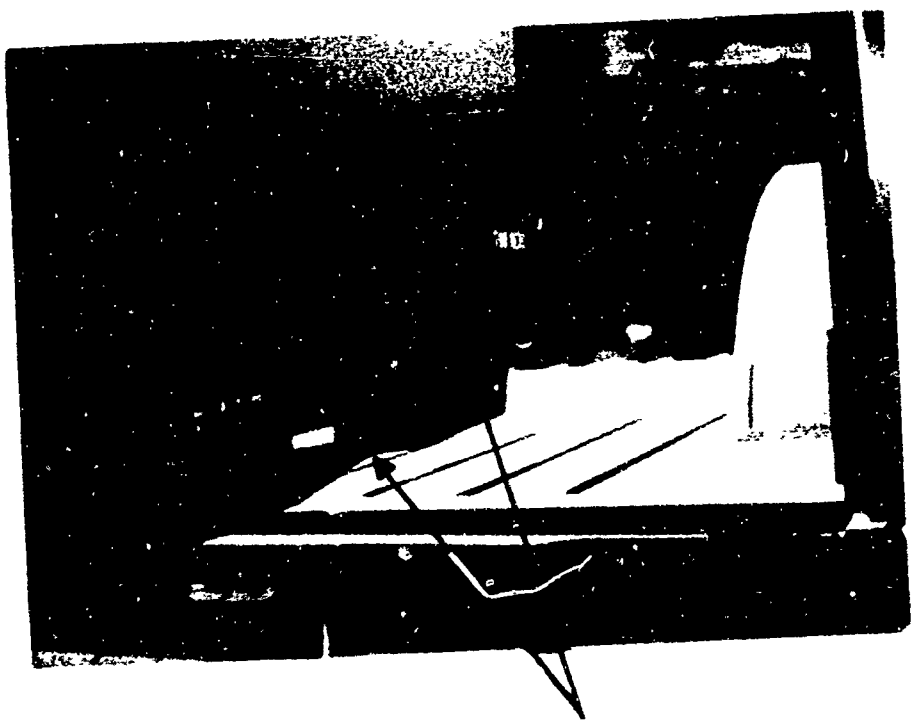

FIGURE 24. DROP TEST - EXTERNAL SHELTER DAMAGE

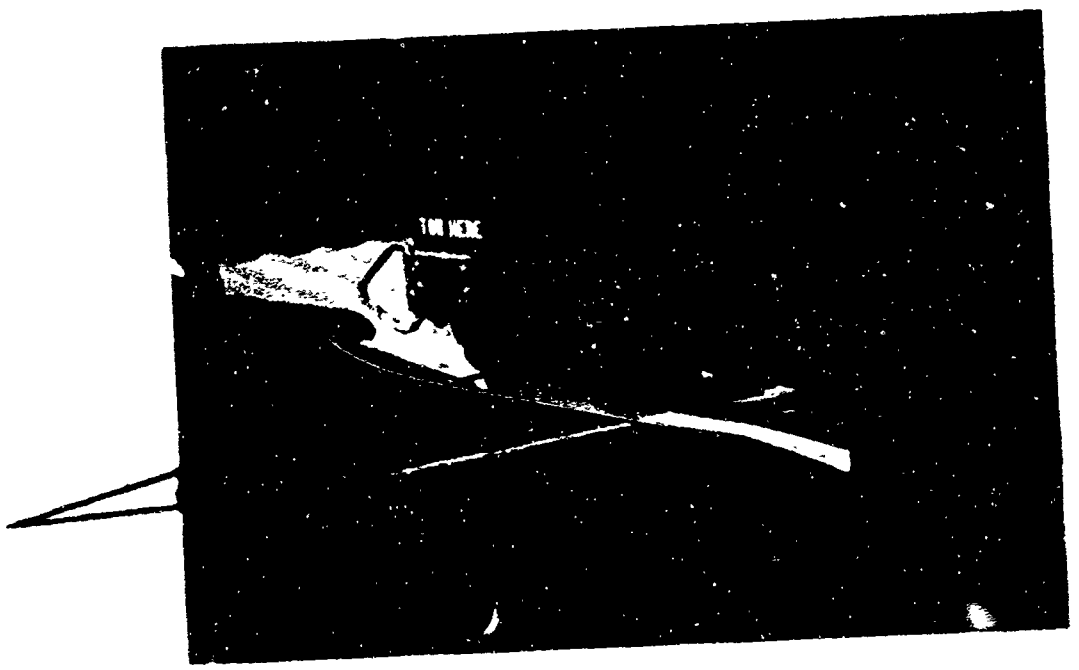

FIGURE 25. DROP TEST -EXTERNAL SHELTER DAMAGE

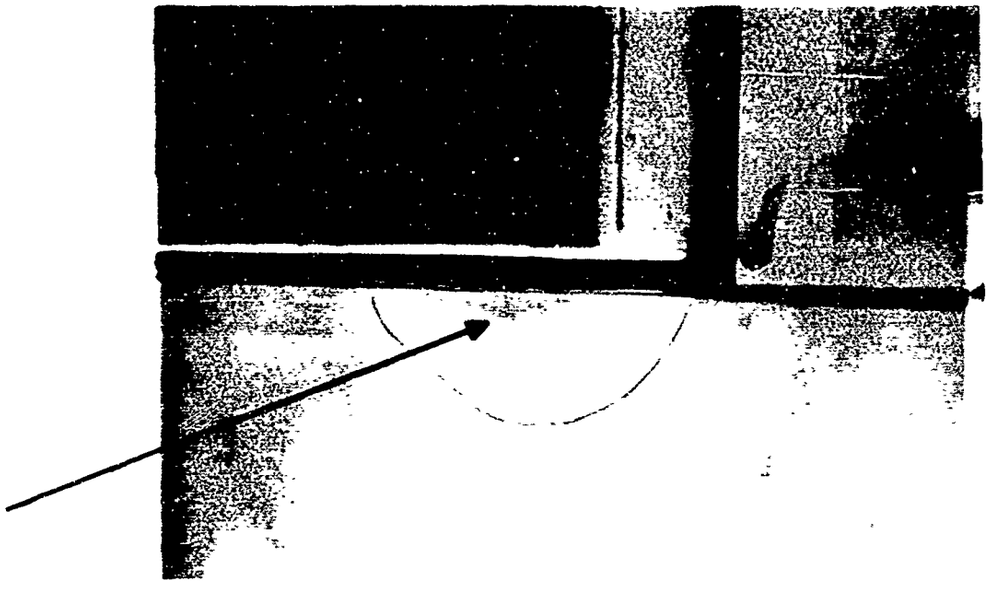

FIGURE 26. DROP TEST - INTERNAL SHELTER DAMAGE

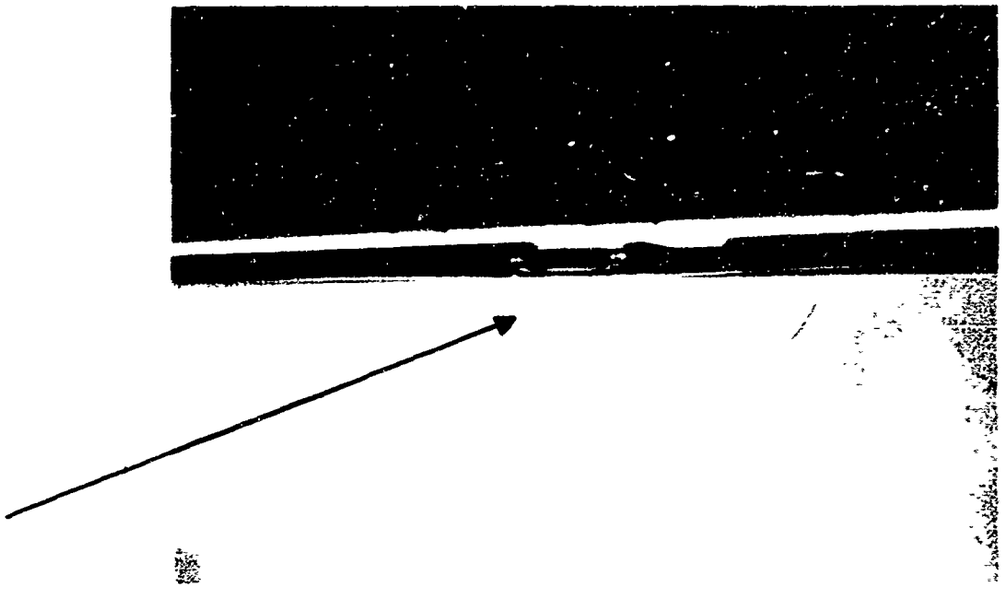

FIGURE 27. DROP TEST - INTERNAL SHELTER DAMAGE

Repair Division. These people stated that this problem is characteristic of the AN/PRC-47 and was unrelated to the system testing.

6. Heat Test - The system, with all components installed, was operated continuously with all components on for a period of eight hours. The air conditioner remained off and the blower fans remained on during the test.

The AN/PRC-47 transceiver was keyed at its specified maximum duty cycle at high power throughout the duration of the heat test. To accomplish this, the drain plug was removed from the shelter floor and wires were run from an external key through the drain hole to the transceiver. The following table shows the front panel temperatures of the various system components at the completion of the heat test. Measurements were made by placing a Weston Model 2261 thermometer in contact with each front panel. Figure 28 indicates the temperature readings taken at various points on the shelter external surface at the completion of the heat test.

A system operational check at the completion of the heat test indicated no damage to the system or its components.

System Selector Panel	136° F
Intercom	120° F
DC Power Supply	140° F
AN/URR-52A Receiving Set	127° F
R-1122 Receiver	124° F
Audio Recorder (top)	125° F
AN/PRC-47 Radio Set	114° F
AFSAV 39C Rekeyer	110° F
Aisle Temp 30" from floor	105° F

Room Temperature 82° F

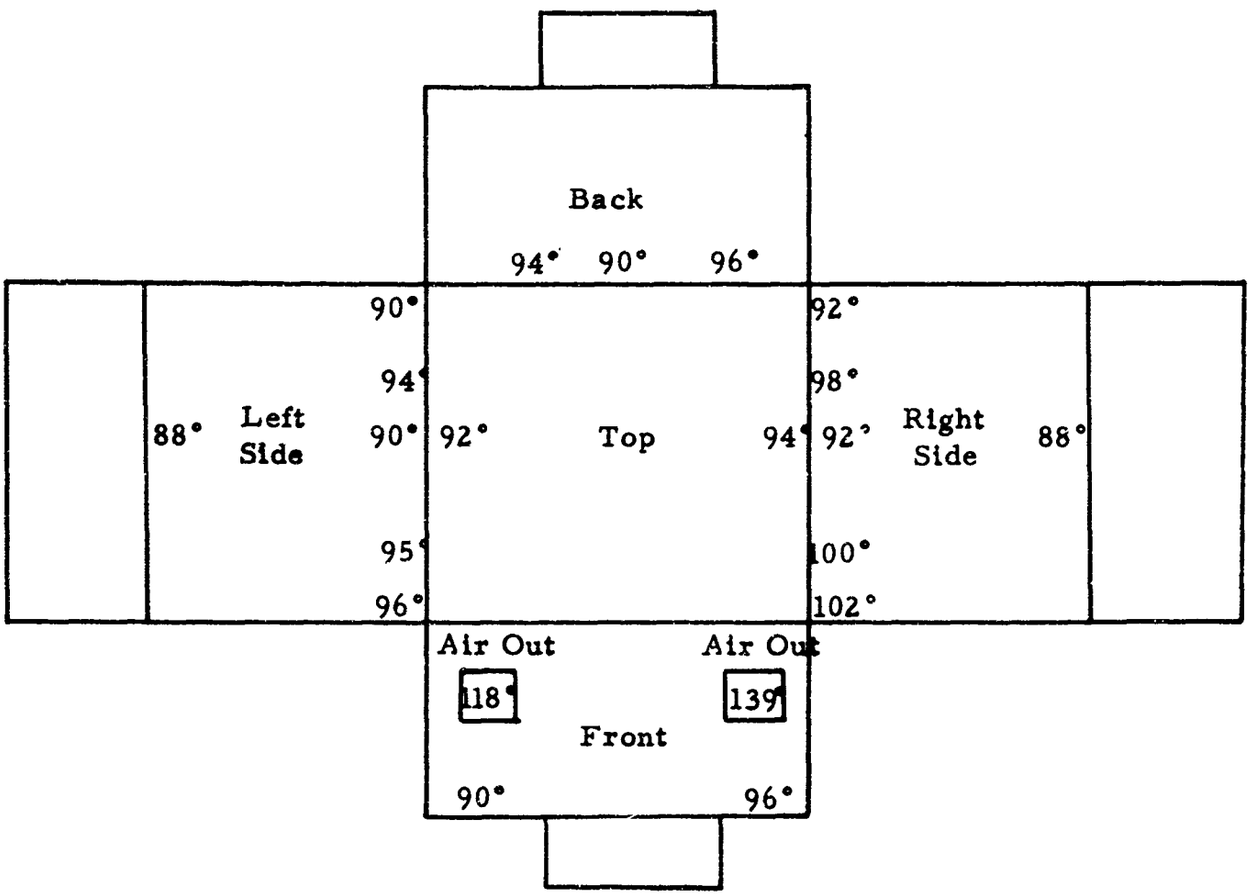

FIGURE 28. HEAT TEST - EXTERNAL SHELTER TEMPERATURES

COMMENTS AND RECOMMENDATIONS

1. Experienced test personnel indicate that it is not uncommon for an item of component equipment to survive shock and vibration testing and then fail within the next few hours of operation due to stresses induced during the testing. It is felt that this pitfall was avoided in the tests described in this report since the eight-hour heat test was the final test performed.

2. The particular M37 truck used for these tests had two hex head bolts protruding from the center reinforcing strut in the forward bulkhead of the truck bed. During the tests, these bolts punctured the outside skin of the shelter (Figure 29). These bolts are not believed to be standard on all M37 trucks; but if they are standard, it is recommended that a protecting plate be installed on the front of future procurement shelters.

3. During the course of the truck and rail transport tests, the shelter tie-down arrangement permitted movement of the shelter sufficient to deform the forward bulkhead of the truck bed as shown in Figures 30 and 31. It is recommended that a tie-down arrangement be designed to eliminate this shelter motion.

4. The diagonal tie-down cables used for the rail transport test are anchored to a bracket installed on the side of the truck bed. Prior to the test the shelter cleared the bracket by nearly 1/2 inch. After completion of the rail transport test, the shelter had settled onto the bracket sufficiently to deform

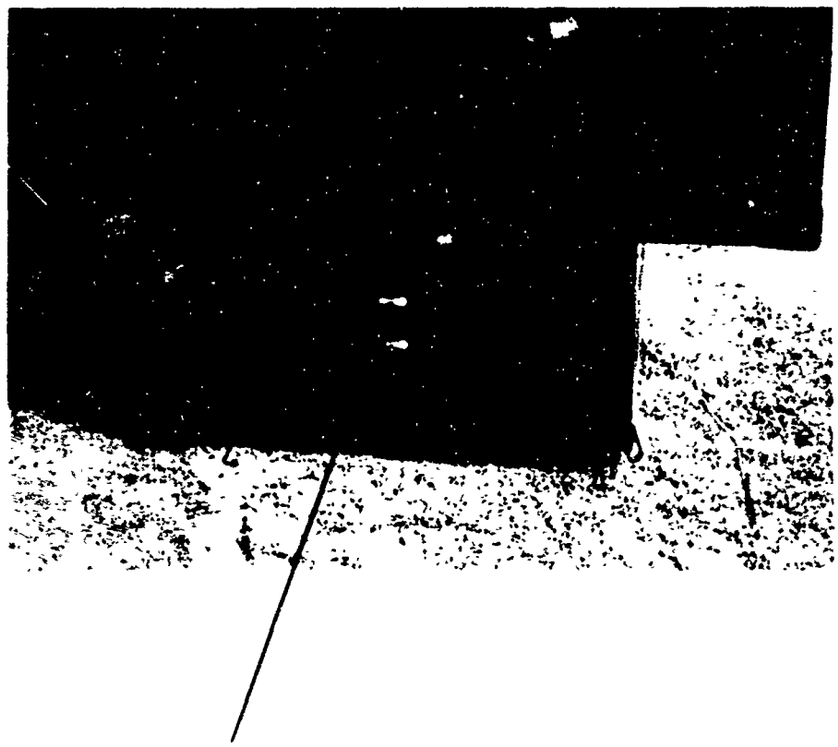

FIGURE 29. SHELTER DAMAGE DUE TO BOLTS IN TRUCK BED

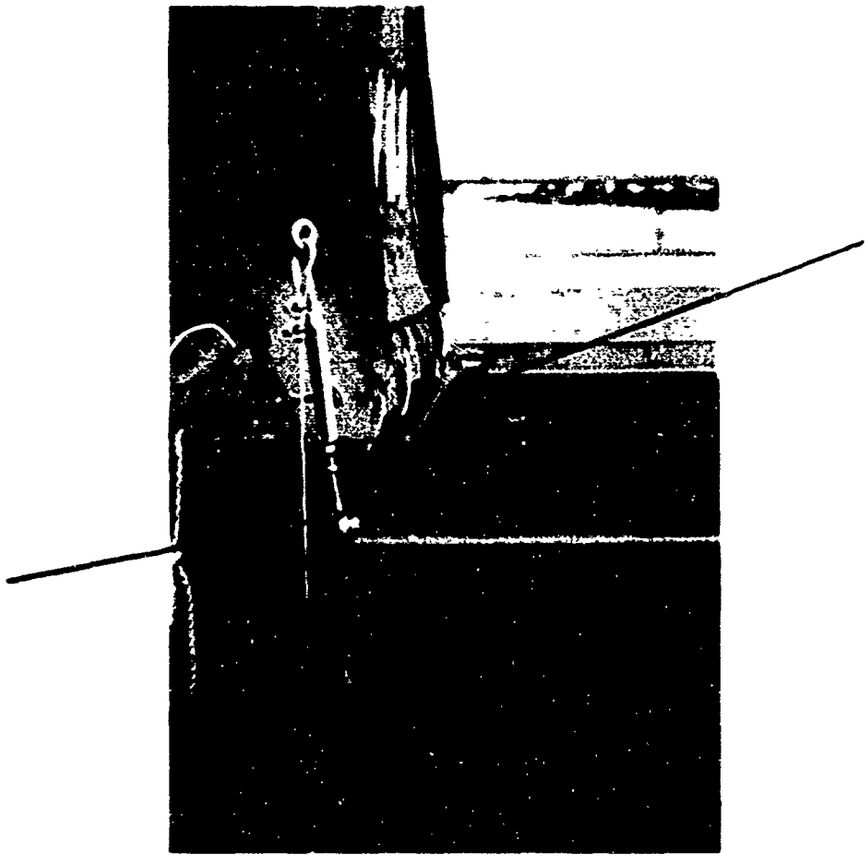

FIGURE 30. DAMAGE TO M37 TRUCK BED

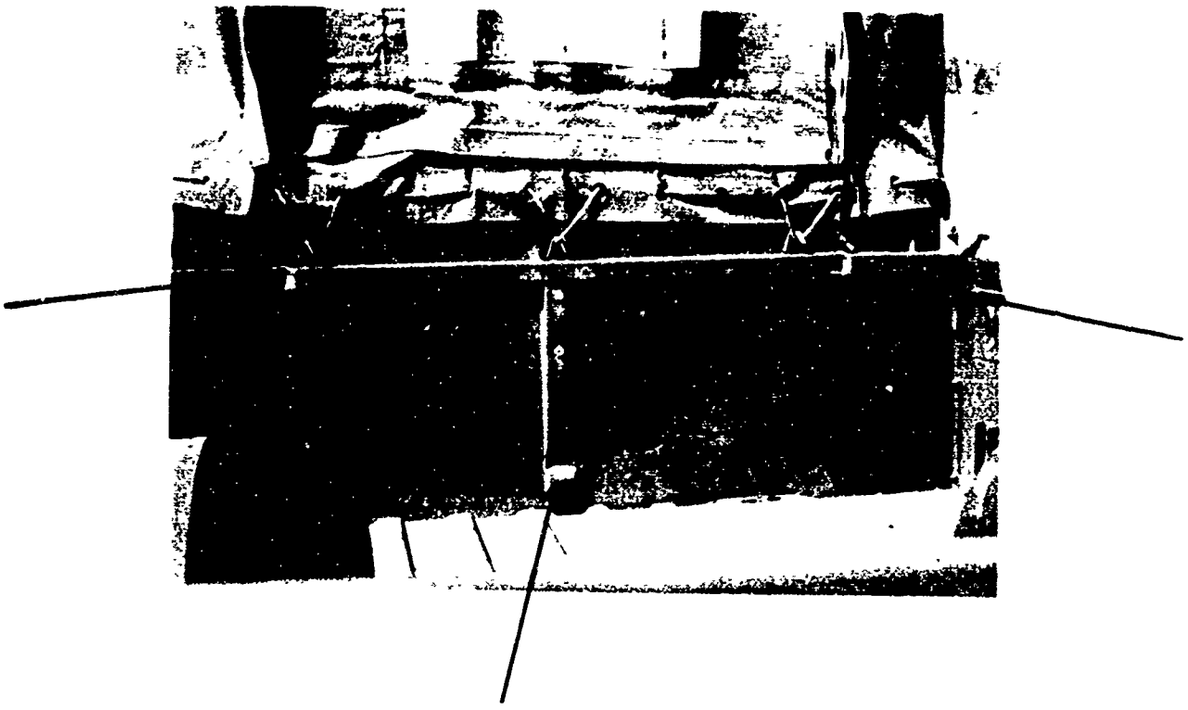

FIGURE 31. DAMAGE TO M37 TRUCK BED

FIGURE 32. SHELTER DAMAGE DUE TO TIE-DOWN BRACKETS

the shelter as shown in Figure 32. It is recommended that, if this tie-down method is to be used, more initial clearance be allowed between the shelter and the bracket.

5. It is recommended that the shelter always be installed on an M37 truck when being land transported.

6. It was originally thought that the non-standard skids with fork-lift holes would facilitate handling of the shelter. Experience has shown, however, that the fork lift holes are seldom, if ever, used. Furthermore, solid skids would undoubtedly have lessened the external damage sustained by the shelter in the drop test. It is therefore recommended that standard solid skids be installed on the shelters used for procurement systems.

7. During the drop test, it was noted that one cable of the sling used to suspend the shelter passed quite close to the mounting insulator for the AN/PRC-47 antenna. It is recommended that this insulator be installed back somewhat from the front corner of the shelter on future procurement systems.

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13 ABSTRACT

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Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Electronic Countermeasures Radio Receivers Shelters Tape Recording Teletype Processing Spectra Display						

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